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SUSCEPTIBILITY OF POTATO VARIETIES AND SEEDLING SELECTIONS TO CORKY RINGSPOT[1]

A. H. EDDINS[2]

Corky ringspot of potato was first reported in the United States by Eddins *et al.* (1) at Hastings, Florida, in 1946. The disease has persisted in fields in which it was first observed and has been found in other fields scattered throughout the Hastings potato section. The trouble has varied in severity from year to year. Some fields have been abandoned for potato culture due to excessive losses caused by the disease. Sebago and Red Pontiac, the leading potato varieties grown at Hastings, are very susceptible to corky ringspot.

Progress in developing a control for potato corky ringspot has been slow as the nature of the disease was not indicated until recently. In 1957 Webb and Schultz (3), using field-grown corky ringspot tubers from Hastings, Florida, found that one or more unidentified viruses was present in diseased plants grown from these tubers. Evidence by Walkinshaw and Larson (2) in 1958, suggested that this disease is caused by a soil-borne virus which they named the "potato corky ringspot virus (PCRV)." The virus was consistently recovered from field soil as well as from field-grown diseased tubers from Hastings. In addition, the virus was recovered from a certain percentage of plants grown from diseased tubers. Recent communications with these workers[3] stated that this soil-borne virus could cause corky ringspot symptoms in potato tubers.

Studies dealing with climatic, soil and nutritional factors which may affect development of corky ringspot have been underway at Hastings since 1946, and the results will be reported in another article. This paper deals with studies aimed at determining susceptibility of potato varieties and seedling selections to the disease.

MATERIALS AND METHODS

Twenty varieties and 33 USDA seedling selections[4] were grown one to eight years in replicated plots in soil where potatoes had been severely affected with corky ringspot. Tubers of US 1A and 1B sizes produced by each variety and selection were examined for external symptoms of the disease which are shown in figure 1. When there was doubt about external symptoms being those of corky ringspot, the tubers were sliced and examined for internal symptoms which are illustrated in figure 2. Weights of corky ringspot-affected and non-affected tubers were recorded for each plot and the percentage of affected tubers in each variety and selection was obtained by dividing the weight of the affected tubers by the weight of the tubers examined. Results of the tests are summarized in table 1.

[1]Accepted for publication September 29, 1958.
Florida Agricultural Experiment Station Journal Series, No. 790.
[2]Plant Pathologist in Charge, Potato Investigations Laboratory, Hastings, Fla.
[3]By letter dated September 11, 1958, and written by C. H. Walkinshaw.
[4]Seed tubers of the seedling selections and most of the varieties were furnished by Doctors F. J. Stevenson and Robert V. Akeley, Vegetables and Ornamental Research Branch, USDA, Plant Industry Station, Beltsville, Md.

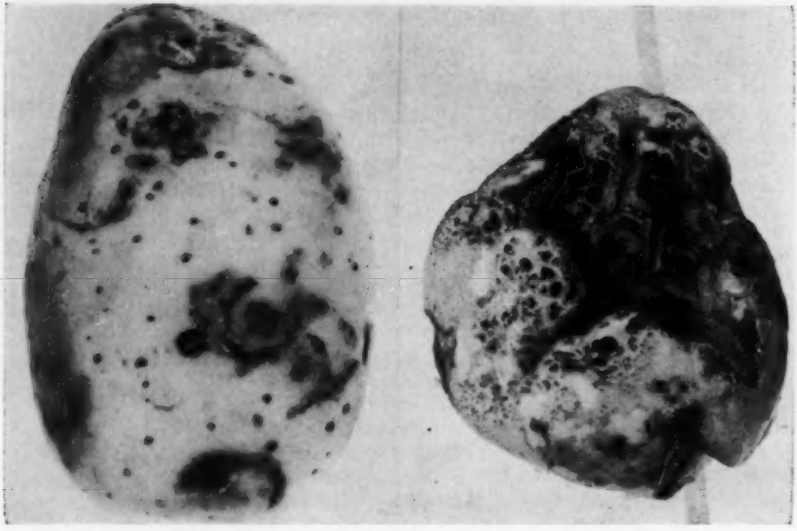

FIGURE 1.—Corky ringspot rings, arcs and discolored areas on the surface of tuber (left) and cracking, corking and malformation produced by the disease in another tuber.

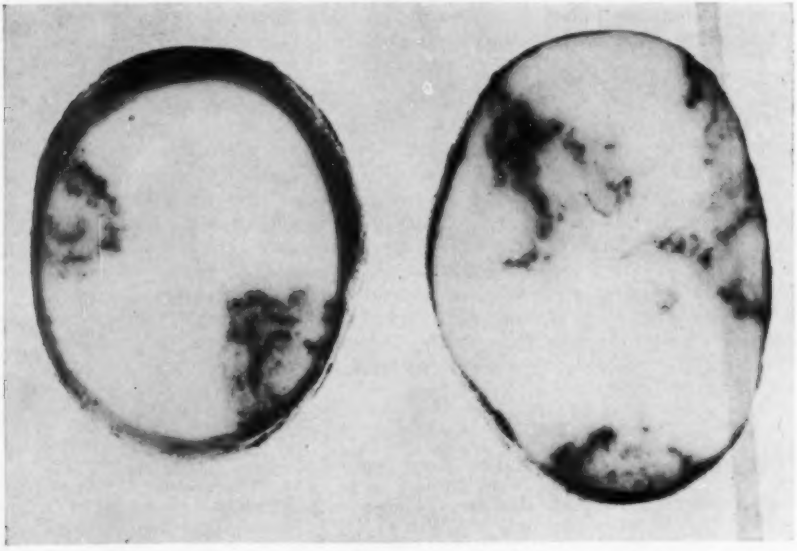

FIGURE 2.—Typical corky ringspot discoloration produced in the flesh of tubers sliced to show these symptoms.

TABLE 1.—*Susceptibility of potato varieties and seedling selections to Corky Ringspot.*

Variety or Selection	Percentage Tubers with Corky Ringspot Symptoms								Range in Percentage Tubers Affected	Number Years Tested
	1951	1952	1953	1954	1955	1956	1957	1958		
Antigo	..	..	..	..	..	..	..	10.5	10.5	1
Bliss Triumph	1.6	..	..	..	..	0	..	..	0- 1.6	2
Boone	..	..	..	..	..	0	0	0	0	3
Canso	0	..	..	1.0	..	..	..	..	0- 1.0	2
Cherokee	..	0	1.1	..	..	0	0	11.2	0-11.2	5
Delus	..	..	..	..	..	0	0	0	0	3
Eigenheimer	..	..	..	..	..	..	0	0.1	0- 0.1	2
Kennebec	0	..	30.1	..	..	0	55.4	25.2	0-55.4	5
Keswick	2.7	..	..	..	..	..	..	..	2.7	1
LaSalle	0	..	..	3.3	..	..	..	..	0- 3.3	2
Merrimack	0	0	0	0	0	0	..	0.3	0- 0.3	7
Plymouth	7.0	0	0	0	0	0	0	0	0- 7.0	8
Pontiac	0	..	17.6	..	..	..	..	..	0-17.6	2
Pungo	0	0	0.4	..	..	0	0	0	0- 0.4	6
Red Pontiac	..	..	..	0.4	0	1.0	69.1	10.3	0-69.1	5
Red Warba	..	..	..	1.8	0	..	0	..	0- 1.8	3
Russet Sebago	..	..	..	12.6	0	..	..	..	0-12.6	2
Saco	..	..	..	..	0	0	0	0.2	0- 0.2	4
Sebago	3.0	53.2	1.1	11.9	0	0.9	74.0	21.1	0-74.0	8
White Rose	..	..	..	..	..	..	..	0.4	0.4	1
B278-27	13.4	0	5.9	..	..	..	..	..	0-13.4	3
B294-29	3.5	0	0.9	..	..	..	..	..	0- 3.5	3
B294-65	0	0	0	0	0	0	0	0	0	8
B313-8	..	..	0	0	..	..	..	..	0	2
B313-21	0	0	..	0	0	0	0	..	0	6
B351-44	0	61.9	2.4	..	..	..	..	..	0-61.9	3
B355-24	1.4	0	0	..	..	..	..	..	0- 1.4	3
B355-35	4.2	0	44.6	..	..	..	..	..	0-44.6	3
B381-2	0	0	0	0	0	0	0	3.3	0- 3.3	8
B505-75	0.7	0	0	..	..	..	..	..	0- 0.7	3
B595-76	0	0	0	0	0	0	0	9.1	0- 9.1	8
B595-135	0	0	23.0	..	..	..	..	..	0-23.0	3
B605-10	3.9	0	43.9	..	..	..	..	..	0-43.9	3
B606-3	0	0	0	0	0	0	0	0	0	8
B616-58	0	0	36.7	..	..	..	..	..	0-36.7	3
B721-1	0	0	0	0	0	0	..	..	0	6
B738-16	0	..	..	..	..	..	..	..	0	1
B780-22	0	0	22.8	..	..	..	..	..	0-22.8	3
B884-19	0.8	31.8	5.0	..	..	..	..	..	0.8-31.8	3
B905-1	0	69.6	21.6	..	..	..	..	..	0-69.6	3
B911-10	0	0	4.4	..	..	..	..	..	0- 4.4	3
B920-7	11.4	0	0	..	..	..	..	..	0-11.4	3
B930-11	2.7	0	0	..	..	..	..	..	0- 2.7	3
B936-12	0	0	0	0.8	..	..	..	..	0- 0.8	4
B962-9	0	0	0	0	..	0	0	0.9	0- 0.9	7
B2098-35	3.9	0	0	..	..	..	..	..	0- 3.9	3
B2896-11	..	0	44.9	..	..	..	..	..	0-44.9	2
B2900-1	..	0	21.5	..	..	..	..	..	0-21.5	2
B2911-21	..	0	0	1.9	..	..	..	..	0- 1.9	3
B3010-3	..	..	0	..	..	..	..	..	0	1
B3010-4	..	0	0	0	0	0	0	31.4	0-31.4	7
B3013-5	..	0	0	0	..	..	..	..	0	3
B3027-19	..	13.1	4.6	..	..	..	..	..	4.6-13.1	2

Results

The fact that corky ringspot varied in severity from year to year and from one location to another in the same test plots where formerly it had been uniformly severe made it difficult to obtain the desired information on reaction of the varieties and selections to the disease. The disease was severe in test plots of susceptible Sebago two years; moderately severe, two; mild, three and not present, one year.

Of the 53 varieties and selections tested from 1951 to 1958, no symptoms of corky ringspot were detected in B294-65 and B606-3 for eight years, B313-12 and B721-1 for six years, B3013-5, Boone and Delus for three, and B313-8 for two years. Tuber infection was less than one per cent in B505-75, B936-12, B962-9, Merrimack, Pungo and Saco which were grown in infested soil three to seven yeras. The disease did not appear in B3010-3 and B738-16 and was found in 0.4 per cent of the tubers of White Rose in the one year they were tested. Only 0.1 per cent of the tubers of Eigenheimer were affected with the disease in one of the two years it was grown. Tuber infection was one per cent or larger in other varieties and selections tested. The most susceptible varieties were Sebago, Red Pontiac and Kennebec.

During the course of this work care was taken to identify corky ringspot symptoms in affected tubers correctly. However, some affected tubers may have been overlooked and symptoms seen in some tubers and classified as those of corky ringspot may have been due to other causes. In doubtful cases of corky ringspot infection it would be necessary to isolate and identify the causal virus in each tuber suspected as being affected with the disease. This method of identifying the disease was not used in the work reported.

Summary

Differences in the susceptibility of 20 potato varieties and 33 USDA seedling selections to corky ringspot were demonstrated by growing them in infested soil at Hastings, Florida. B294-65, B313-21, B606-3, B721-1, B3013-5, Boone and Delus were free from corky ringspot symptoms, and tuber infection did not exceed 0.9 per cent in B505-75, B936-12, Merrimack, Saco and Pungo in the three to eight years they were tested. Maximum percentages of tuber infection in the most susceptible varieties, Kennebec, Red Pontiac and Sebago, ranged from 55.4 to 74 per cent.

Yield and other characteristics of the corky ringspot-resistant varieties and selections have been compared to determine their suitability for commercial production in the Hastings area. At present, Merrimack, Pungo and Plymouth are recommended for planting in infected fields where corky ringspot susceptible Sebago and Red Pontiac cannot be grown profitably.

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POTATO MERISTEM CULTURE AND VIRUS X[1]

F. E. MANZER[2]

INTRODUCTION

Virus X disease, well-known throughout the potato growing regions of the world, is known to cause yield reductions ranging from negligible, to as high as 75 per cent depending on virus strain, potato variety, and environmental conditions. This disease has been controlled mainly by eradication of diseased tubers from partially infected seed stocks and by the use of immune varieties. Many strains of virus X produce no visible symptoms on potato; therefore specialized methods for detection are required. Before these methods were available, many of the older varieties which are still grown today, became universally infected. To obtain increased yields, elimination of virus X from such varieties has been attempted. Meristem culture and malachite green treatment have been used successfully by some workers for this purpose. One virus X-free clone of the variety Green Mountain was obtained by Norris (5) from 83 malachite green-treated meristem subcultures. Thomson (7) was unable to find any virus-free plantlets from 154 dye-treated meristem cultures. Morel and Martin (4), on the other hand, reported consistent elimination of potato viruses X, Y, and A, using only meristem culture. Kassanis (3) found 4 out of 5 untreated meristem cultures free from virus, but his cultures produced only callous growth and a small amount of tissue was thus available for testing.

The present study was undertaken to investigate the effectiveness and practical aspects of Norris' method as a routine procedure for the elimination of Virus X.

MATERIALS AND METHODS

Parent meristems 1 - 2 mm. long were started from either tuber sprouts or apical and axillary buds from growing plants. These meristems were excised, dipped momentarily in 70 per cent ethanol, and placed in a 10 per cent solution of commercial Clorox for 10 minutes. They were then moved to a holding solution of one per cent Clorox from which they were transferred to media.

White's solution (8), used by Norris, was prepared according to a recent formulation by White (9). It was discovered and later confirmed through communication with Dr. P. R. White, that typographical errors had been made in the 1954 edition and the correct formulation was that listed in the 1943 edition. Coconut milk and 2,4-D (6) were added to White's medium in one experiment and in another the medium was supplemented with water extract (2) of autoclaved potato tubers. One-half

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This paper is a portion of a thesis submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy at Iowa State College, Ames, Iowa.
[2]Formerly graduate assistant, Department of Botany and Plant Pathology, Iowa State College; now Assistant Plant Pathologist, Department of Botany and Plant Pathology, University of Maine, Orono, Me.

strength Knop's solution (4) was used with White's vitamin formulation plus 2 per cent sucrose. Media containing 1 ppm. of naphthaleneacetic acid were used until growth was initiated.

Microscope slides, wrapped with two thicknesses of Whatman No. 1 filter paper, were placed in new, wide-mouth 250 ml. pyrex erlenmeyer flasks containing 50 ml. of liquid media, an adaptation of a method described by Norris (5). The filter paper acted as both a wick and a support for the culture (Figures 1, 2, and 3). Meristem cultures on agar were grown in eight-ounce glass bottles, petri plates and erlenmeyer flasks.

Subcultures of parent meristems were treated with malachite green dye at rates of four and eight ppm., and with thiouracil, a chemical reported to inhibit virus X (1), at rates of 5 and 10 ppm. The chemicals were sterilized either by autoclaving or by passage through a bacterial filter and added aseptically to the cultures. After 1 to 3 weeks, cuttings from treated meristem cultures were placed on fresh media where they were allowed to recover and resume growth before transfer to soil.

To prevent transplanting shock, it was necessary to pre-condition plantlets before transfer to soil by placing them in covered glass dishes containing moist vermiculite or perlite. Covers were removed periodically to allow some exposure to drier air and finally were removed entirely. When plantlets became well-rooted and green, they were transferred to small pots of sterilized soil and covered with beakers until established. When plantlets were 2 to 3 inches high, (Figure 4) they were tested for the presence of virus X with the local lesion test plant, *Gomphrena globosa* L.

Experimental Results

Considerable difficulty was experienced in establishing meristem cultures and in maintaining satisfactory growth. All modifications of White's medium and other media gave erratic results, so White's standard medium was used for most of the work. Shoot elongation apparently progressed most rapidly at 70° F. in darkness; however, many cultures did not grow even under these conditions. Additional cultures were lost because of contamination by microorganisms.

Most malachite green-treated meristem cultures were successfully recovered after treatment but no cultures survived the thiouracil treatments. Transfer of cultures from nutrient medium to soil proved to be difficult. Only 20 of 133 treated and untreated meristem cultures survived for testing and all of these 20 contained virus X (Table 1). Evidence based on comparisons of lesion numbers on test plants indicated no reduction in virus titer due to the malachite green treatment.

The size of the cutting may or may not be the key to successful virus X elimination by meristem culture. Sprout apices of 100 to 250 microns as used by Morel and Martin and by Kassanis yielded virus-free tissue, but all of Norris' subcultures were 2 to 5 mm. long and were made from a parent meristem initially 200 microns long. Since only one of his treated subcultures proved to be virus-free, the original meristem obviously contained virus, so 200 micron cuttings are not necessarily virus-free (Figure 5). Although Norris concluded that malachite green treatment eliminated virus X in one of his 2 to 5 mm. long subcultures, treated

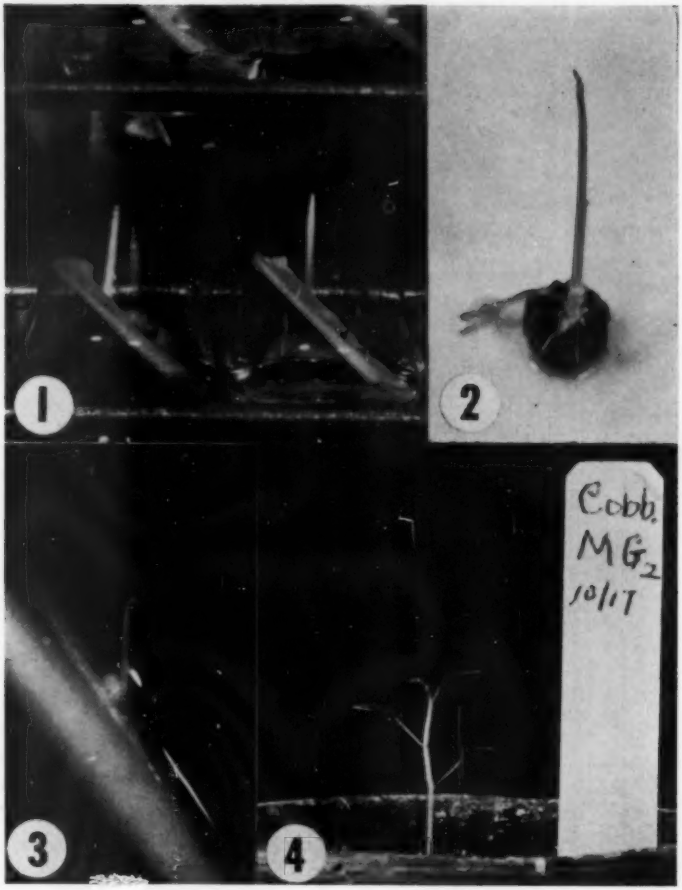

FIGURE 1.—Parent meristem cultures from potato tuber sprouts growing on filter paper slopes in 250 ml. Erlenmeyer flasks containing liquid media.
FIGURE 2.—Parent potato meristem culture with root and shoot growth.
FIGURE 3.—Apical subcutting from potato meristem culture.
FIGURE 4.—Plantlet from potato meristem culture.

meristems of comparable size used by Thomson and the author yielded no virus-free plantlets.

Considerable difficulty was experienced in establishing and maintaining growth of meristem cultures and in addition many cultures were lost during transfer to soil. In view of the difficulties encountered and apparent limited effectiveness of meristem culture for virus X elimination, this method appears to be impractical for routine potato improvement work.

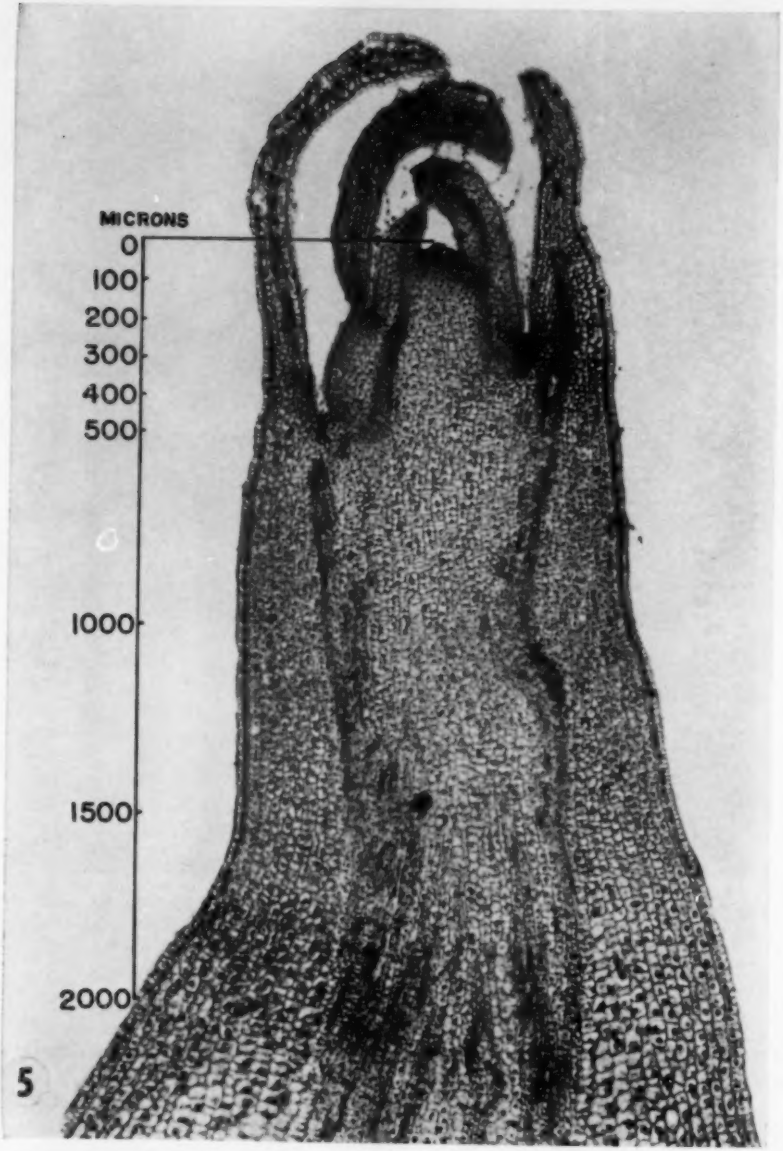

FIGURE 5.—Potato tuber sprout tip (approximately 60X).

TABLE 1.—*Survival of potato plantlets from meristem cultures following treatment and transfer to soil.*

Variety	Treatment	Rate in Ppm.	Number Treated	Number Surviving[1]
Irish Cobbler	Malachite Green Dye	4	20	3
"	"	8	20	4
"	Thiouracil	5	10	0
"	"	10	10	0
"	Untreated	..	20	2
Red LaSoda	Malachite Green Dye	4	15	2
"	"	8	15	3
"	Untreated	..	20	5
Russet Burbank	Untreated	..	3	1
Totals			133	20

[1]All survivors gave positive virus X tests on *G. globosa*.

SUMMARY

Parent meristem apices, subcutting, and re-isolations, with and without malachite green treatment, were cultured on several types of liquid and solid media. Considerable difficulty was experienced in achieving and maintaining satisfactory culture growth. No potato plantlets free of virus X, nor any showing a measurable reduction in virus titer were obtained. From a practical standpoint, meristem culture with or without malachite green treatment for virus X elimination is apparently of little value for routine potato improvement work.

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OBSERVATIONS ON RACES OF *PHYTOPHTHORA INFESTANS* IN MEXICO DURING 1956-1957.[1]

K. M. GRAHAM,[2] J. S. NIEDERHAUSER[3] AND SEBASTIAN ROMERO[4]

INTRODUCTION

During 1956 and 1957 a survey was made of physiologic races of *Phytophthora infestans* (Mont.) de Bary, in Mexico. Blighted material was collected from cultivated potato varieties, and from hybrids between cultivated varieties and the Mexican wild species, *Solanum demissum* Lindl., under test at the Santa Elena Experiment Station in the valley of Toluca where late blight occurs annually in epiphytotic proportions. Collections of blight were also made from *S. demissum* in its natural habitat in the mountains surrounding the valleys of Toluca and Mexico. Inoculum propagated from these sources was used to inoculate differential varieties of potato (*Solanum tuberosum* L.) and tomato (*Lycopersicon esculentum* Mill.) and attempts were made to classify the races on the basis of the reactions they produced. The tuberous species *S. bulbocastanum* Dun., *S. cardiophyllum* Lindl., *S. oxycarpum* Schiede and *S. stoloniferum* Schlecht., which have appeared to be promising sources of resistance, were also studied as possible harborers of any uncommon pathogenic races.

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METHODS

Each collection consisted of a single leaflet of potato or tomato with a single lesion bearing sporangia of *P. infestans*. The leaflets were placed in moistened paper bags or in Petri dish moist chambers for transfer to the laboratory. At the laboratory, they were incubated in moist chambers at 11-13° C. for 24 hours to stimulate the production of fresh sporangia. Spores from each collection were suspended in approximately 20 to 25 ml of sterile, chilled distilled water. The suspensions were then incubated in shallow layers on Petri dishes for 2 to 3 hours at 11-13° C. Small pieces of absorbent cotton were soaked in the spore suspension in the Petri dishes, and two cotton swabs bearing the germinated zoospores of each collection were placed upon a leaflet of each differential. The potato differentials included the single-gene host series adopted by Black, Mastenbroek, Mills and Peterson (3), and two tomato varieties, Stokesdale and Geneva T-5, the genotypes of which Graham (5) has designated "r^t" and "R_1^t," respectively. After inoculation, the plants were placed in a moist chamber for approximately 36 hours at 18-20° C., then removed to a cool greenhouse.

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Joint contribution from the Botany and Plant Pathology Division, Science Service, Canada Department of Agriculture, Ottawa, Ontario, and the Oficina de Estudios Especiales, Secretaria de Agricultura y Ganaderia (cooperative agricultural program between the S.A.G. and the Rockefeller Foundation), Londres 40, Mexico 6, D.F. Contribution No. 1718 from the Botany and Plant Pathology Division and Paper No. 104 of the Agricultural Journal Series of the Rockefeller Foundation.

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[3]Plant Pathologist, Rockefeller Foundation.

Susceptibility was indicated by the development of spreading lesions four days after the time of inoculation. Resistance was shown by pin-point lesions, or dendritic necrotic spots characteristic of hypersensitive reactions.

The methods described above were used when it was possible to obtain an abundant crop of sporangia on leaves collected from most of the derivatives of *S. demissum* x *S. tuberosum* and from tomatoes. Sporulation on other species, however, was so sparse that it was necessary for isolations to be made after infection was first established in the variety Bintje, the "r" potato differential. The leaves with the lesions were washed, immersed in a 1:5 dilution of the commercial preparation Clorox (active ingredient: 12.6 per cent hypochlorite) for 3 minutes, and rinsed in two changes of sterile water. Small strips of leaf tissue were cut from the characteristic water-soaked margins of the lesions. These were set edgewise into a layer of 2 per cent lima-bean agar or 1.4 per cent oat-extract agar. Usually hyphae, free from bacteria, grew from the leaf tissue within 48 hours, and sub-cultures were made on slants of 1.4 per cent oatmeal agar. Inoculations of differentials were made with cultures from 10 days to three weeks old.

Observatons of Races of *P. infestans*

Fifteen of the collections determined from a group of Mexican varieties of *Solanum tuberosum* were races capable of attacking hosts with a single gene for resistance (Table 1). In addition 5 were found which could attack genotypes combining 2 genes and 2 which could attack genotypes combining 3 genes. A group of European and American varieties which lacked genes for resistance yielded 31 collections that included races which fell in the "single-gene" category, 10 which could attack combinations of 2 genes, and 7 which could attack genotypes combining 3 genes or more. The variety Kennebec, which is resistant to race *0* (zero) yielded 2 determinations of race *1.4*.

Also shown in table 1 are the results of race determinations from two groups of F_1 hybrids between *S. demissum* and *S. tuberosum*. The first, a natural hybrid known locally as "morada silvestre," yielded 5 determinations of race *1.2.4* and 4 of race *1.2.3.4*. The second group of hybrids between *S. demissum* and U.S. 96-56, produced one determination each of races *1.2*, *1.3*, and *1.4*, 3 of race *1.2.4*, one of race *2.3.4*, 4 of race *1.3.4*, and 6 of race *1.2.3.4*.

Blighted material from *S. demissum* was collected from plants growing in the field on the slopes of Mt. Popocatepetl and from selections of parental material sent by Mr. H. T. Davies from the potato breeding program of the Canada Department of Agriculture at Fredericton, New Brunswick, and under test in the Campo de Santa Elena during 1956. On the Popocatepetl material, race *1.2.4* occurred twice and race *1.2.3.4* was determined 5 times. The material from Fredericton yielded 14 determinations of race *1.2.4* and 3 of race *1.2.3.4*.

Also shown in table 1 are the results of 9 determinations of collections from Stokesdale and San Marzano tomatoes, which had been growing during 1956 in the Campo de Santa Elena and in the experimental plots at Chapingo. Races *0* and *4*, which are relatively common, occurred 3 times, races *1.2*, *1.4*, and *2.4* occurred once each, race *2.3.4* was found once, and race *1.2.3.4* was found twice.

TABLE 1.—*Summary of determinations* of races of Phytophthora infestans causing lesions on potatoes and tomatoes.*

Species or Hybrid	Source and Description	Number of Determinations of Indicated Race																					Total
		0	*1*	*2*	*3*	*4*	*1.2*	*1.3*	*1.4*	*2.3*	*2.4*	*3.4*	*1.2.3*	*1.2.4*	*2.3.4*	*1.3.4*	*1.2.3.4*						
Solanum tuberosum	Mexican "Criolla" susceptible to all races	11	1	0	0	3	1	0	4	0	0	0	0	1	0	1	0						22
S. tuberosum	Group of European & American susceptible varieties	19	5	0	0	7	0	0	6	0	4	0	0	0	0	2	5						48
S. tuberosum	Kennebec, res. to Race *0*, carrying Gene R_1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0						2
S. demissum x *S. tuberosum*	"Morada silvestre" Natural F_1 hybrid from Toluca	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	4						9
S. demissum x *S. tuberosum*	F_1 hybrid with U.S. 96-56, made in Fredericton	0	0	0	0	0	1	1	1	0	0	0	0	3	1	4	6						17
S. demissum	From slopes of Mt. Popocatepetl	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	5						7
S. demissum	Canadian collection from Fredericton	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	3						17
Lycopersicon esculentum	Stokesdale and San Marzano	1	0	0	0	2	1	0	1	0	1	0	0	0	1	0	2						9

*Black, W., *et al.* 1953. A proposal for an international nomenclature of races of *Phytophthora infestans* and of genes controlling immunity in *Solanum demissum* derivatives. Euphytica *2*: 173-178.

BEHAVIOR OF RACES OF *P. infestans* ON TOMATO HOSTS

All of the collections of *P. infestans* made in 1956 attacked Stokesdale tomato, the genotype of which has been designated "r^t" by Graham (5). The latter genotype is distinct from that of Bintje and other blight-susceptible potato varieties that Black (1) considers to bear the recessive gene "r." Of the 147 collections made in 1956, 20 attacked the resistant tomato selection Geneva T-5, which carries a single gene "$R_1{}^t$" for resistance. On the basis of the readings made, such races as *1*^{t}*.4*, *1*^{t}*.1.2.4*, and *1*^{t}*.1.2.3.4* probably exist in Mexico. It was interesting to note that collections of the fungus capable of attacking both tomato varieties were obtained from *S. demissum* growing on the lower slopes of Mt. Popocatepetl at an altitude of 8400 feet above sea level. Six others came from the natural hybrid of *S. demissum* x *S. tuberosum*, "morada silvestre," found on the Nevado de Toluca at 9300-feet elevation.

RELATION BETWEEN THE FIELD RESISTANCE OF CERTAIN MEXICAN WILD POTATO SPECIES AND PHYSIOLOGIC RACES OF *P. infestans* FOUND ON THEM

Determinations were made of the physiologic races of *P. infestans* found among 20 isolates of the pathogen from a few of the wild species under test in the experimental plots in the Campo de Santa Elena and from *S. demissum* found in nature at an altitude of approximately 10,000 feet near Rio Frio and La Marquesa in the State of Mexico (Table 2).

Both tables 2 and 3 show data regarding the occurrence of races on the wild species *S. cardiophyllum*, *S. bulbocastanum*, *S. oxycarpum*, *S. stoloniferum* and *S. demissum*, and their field resistance under epiphytotic conditions at Santa Elena during 1957. Of 5 clones of *S. cardiophyllum* two had been killed by blight by September 18, two other clones were apparently immune, and one S-335 clone survived the summer with a blight reading of "3" according to the arbitrary scale of blight incidence of Mills and Niederhauser (8) (Table 3). The field-susceptible clone S-279 yielded races *0* and *4* (Table 2), whereas it was impossible to obtain sporulation from lesions on the field-resistant clones S-400 and S-402.

Races *1.3.4* and *1.2.3.4* (Table 2) were determined on seedlings of *S. oxycarpum* given final field readings of "3" and "4" (Table 3). Races *3*, *4* and *1.2.3.4* were found on the S-407 clone of *S. stoloniferum*, which proved to be field-susceptible. Unfortunately, sporulation on the field-resistant clone S-455 of *S. stoloniferum* was very sparse and it was impossible to obtain an inoculum from it.

S-434, a clone of *S. demissum* that originated from the Rio Frio area in which races *0* and *4* were found at an elevation of about 10,000 feet and which exhibited the highest degree of field susceptibility among the collection of *S. demissum* exposed to late blight in the Campo de Santa Elena during 1957, yielded one isolate of race *0* and two of race *4* (Table 2). These races had occurred most frequently on the two groups of varieties of *S. tuberosum* which lacked genes for resistance (Table 1). S-406, which might be considered intermediate in its degree of field resistance, with successive readings of "2," "3," and "4" during 1957, yielded races *1* and *1.2*, whereas a third clone, S-449, with a high end-of-season reading of "2," yielded race *1.2.3.4* (Table 2). A blight collection

TABLE 2.—*Summary of determinations* of races of Phytophthora infestans in material collected during the summer of 1957 from wild potato species collected in Mexico.*

Species	Accession Number	Source of Blight Collection	Number of Determinations of Indicated Race																	
			0	*1*	*2*	*3*	*4*	*1.2*	*1.3*	*1.4*	*2.3*	*2.4*	*3.4*	*1.2.3*	*1.2.4*	*2.3.4*	*1.3.4*	*1.2.3.4*
Solanum bulbocastanum	Misc.	Campo de Sta. Elena	0	0	0	0	2	0	0	0	0	1	1	0	0	0	0	0
S. cardiophyllum	S-279	" " " "	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
S. oxycarpum	..	" " " "	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
S. stoloniferum	S-407	" " " "	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1
S. demissum	S-434	" " " "	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
S. demissum	..	Rio Frio	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
S. demissum	S-449	Campo de Sta. Elena	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
S. demissum	..	La Marquesa, Mex.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
S. demissum	S-406	Campo de Sta. Elena	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0

*Black, W., *et al.* 1953. A proposal for an international nomenclature of races of *Phytophthora infestans* and of genes controlling immunity in *Solanum demissum* derivatives. Euphytica *2*: 173-178.

TABLE 3.—*Degree of field resistance exhibited by selected wild potato species and species hybrids during an epiphytotic of late blight in the Campo de Santa Elena during 1957.*

Species or Species Hybrid	Accession Number	Reading of Degree* of Field Resistance on Date Indicated		
		July 27	August 16	September 18
Solanum cardiophyllum	S-279	2	3	5
S. "	S-335	0	0	3
S. "	"	1	4	5
S. "	S-400	0	0	0
S. "	S-402	0	0	0
S. oxycarpum	56-51	..	..	1
S. "	"	..	..	3
S. "	"	..	..	4
S. "	"	..	..	5
S. stoloniferum	S-382	..	..	2
S. "	S-407	..	..	5
S. "	S-412	..	..	4
S. "	S-455	..	..	1
S. demissum	S-399	0	1	2
S. "	S-406	2	3	4
S. "	S-434	4	4	4
S. "	S-438	0	1	2
S. "	S-444	0	0	1
S. "	S-449	0	1	2

*0—No Blight; 1—one to 5 lesions; 2—slight; 3—moderate; 4—severe; 5—dead.

from *S. demissum* at 10,000 feet elevation in the La Marquesa area above the Toluca valley, also yielded race *1.2.3.4*.

As shown in table 2, races *4*, *2.4* and *3.4* were isolated from a collection of seedlings of *S. bulbocastanum* which were grown in the Campo de Santa Elena during 1957. Graham, Niederhauser and Servin (6) have reported varied degrees of field resistance in this material.

DISCUSSION

In the evaluation of the results, it must be kept in mind that the race determinations were based upon the reactions of a set of single-gene differentials. Analyses by confirmatory inoculations on combination-gene differentials might confirm the suspicion that mixtures of races were present, therefore only the races which may be predominant in any given collection are shown in tables 1 and 2. The total number of collections from each host source was small, and it would be dangerous to generalize too freely from the data. Nevertheless, a certain trend towards selectivity on the part of the host is indicated in table 1. From the two groups of varieties of *S. tuberosum* that lacked genes for resistance, the largest numbers of simple races, e.g. *0*, *1*, *2*, and *4*, are recorded. In contrast, no simple races were determined in collections from the two groups of F_1 hybrids between *S. demissum* and *S. tuberosum* and from the two sets

of *S. demissum*. A large proportion of the total number of races collected from these four groups might be classified in the "complex" or relatively highly specialized category, in which races *1.2.4*, *1.3.4*, *2.3.4*, and *1.2.3.4* might arbitrarily be placed. There was little evidence of a selective action by the two tomato varieties Stokesdale and San Marzano.

Black (1), using a technique of serial passage of mixed inocula of different physiologic races through selected differentials, demonstrated that a given race may be favored by a certain genotype upon which the race is apparently specialized. He suggested that a similar selectivity might operate to eliminate highly specialized races if they were released in competition with the common race *0* on susceptible potato varieties. With the available data it is not possible to show concrete proof that a similar selective action is exerted by various genotypes of *S. demissum* upon the race complex of *P. infestans* in Mexico. A trend in this direction is indicated, however, by the large number of relatively common races determined on susceptible types of *S. tuberosum* (Table 1) in comparison with the more highly specialized races obtained from derivatives of *S. demissum* and *S. demissum*. Special attention is drawn to the record of race *0* on *S. demissum* in the Rio Frio area of the state of Mexico and also of race *0* on the S-434 clone, which is known to carry no genes for resistance and which was exposed to blight in the valley of Toluca.

Mills and Niederhauser (8) succeeded in obtaining from *S. demissum* isolates of *P. infestans* capable of attacking all their available differential hosts and clones of *S. demissum*. Therefore, they concluded that Mexican races are considerably more specialized than those to be found in Europe and on the rest of the North American continent and that an unknown number of genes for resistance may be found in *S. demissum*. The occurrence of races identified as *4*, *2.4*, and *3.4* (Table 2) from certain seedlings of *S. bulbocastanum*, which were resistant (6) after inoculation with race *1.2.3.4*, suggests that genes quite distinct from those of *S. demissum* may be discovered in this species. The presence of a single gene for resistance in the genus *Lycopersicon* has been demonstrated by Gallegly and Marvel (4) and by Graham (5). It is suggested that the present international system of nomenclature for races of *P. infestans* should eventually be revised to include the race possibilities that may ultimately occur on species such as *S. bulbocastanum*, *S. cardiophyllum*, *S. pinnatisectum*, and other Mexican diploids.

Data in table 3 indicate that at least 4 Mexican wild-potato species show evidence of heterogeneity with respect to degree of field resistance. Black and Gallegly (2) have reported interesting parallel cases of segregation for resistance and susceptibility to races *1.2.3*, *1.2.4*, *1.3.4*, *2.3.4*, and *1.2.3.4* in seed samples of the species *S. cardiophyllum*, *S. oxycarpum*, *S. stoloniferum* and *S. demissum*. The same authors and Graham, Niederhauser and Servin (6) have observed segregation for resistance in *S. bulbocastanum*. Howatt and Grainger (7) also reported segregation to their race *1.2.3.4* among seedlings of the S-74 clone, which Niederhauser, Cervantes and Servin (9) had used as a supplementary differential in classifying their Mexican isolates. It is not yet possible to relate field resistance of clones of a given species to their known gene complement. The present findings indicate the value of the use of field-tested clones of certain species as sources of breeding material.

SUMMARY

In 1956 a high proportion of races *0, 1, 2* and *4* were found on varieties of *Solanum tuberosum* lacking genes for resistance to late blight. More highly specialized races, such as *1.2.4, 1.3.4,* and *1.2.3.4,* were obtained from lines of *S. demissum* and from hybrids of *S. demissum* x *S. tuberosum.*

In 1957, races *0* and *4* were isolated from *S. demissum* found in the Rio Frio area of Mexico. Race *0* was obtained from an "r"-type clone of *S. demissum* in the Santa Elena Experiment Station in the valley of Toluca.

Seedlings resistant to race *1.2.3.4* of *S. bulbocastanum* yielded isolates of the pathogen identified as races *4, 2.4,* and *3.4,* which indicated the presence of new races of this species.

Intraspecific variation in the degree of field resistance against late blight was noted among clones of *S. cardiophyllum, S. oxycarpum, S. stoloniferum, S. demissum* and *S. bulbocastanum.*

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PHYTIC ACID TREATMENTS FOR PRE-PEELED POTATOES[1]

B. L. Amla and F. J. Francis[2]

The use of salts of sulphur dioxide to control discoloration in pre-peeled potatoes is well established in commercial practice. (4). The process is effective and the ingredients are relatively inexpensive. However, the destruction of up to forty-seven per cent of the thiamine content of the potatoes (1) and the possibility off-flavors due to overdoses of sulphur dioxide has led to searches for compounds that could replace part or all of the sulphur dioxide. Such investigations have not met with much success but Anderson and Zapsalis (2) reported that an ascorbic acid treatment could be used in place of the sulphite treatment if the potatoes were packed in Cryovac bags The present work is concerned with the possibility of replacing part of the sulphite with phytic acid or calcium phytate.

Materials and Methods

The potatoes used in this study were California Long White type and were obtained from a local commercial source.

The potatoes were hand peeled, cut into one inch cubes and kept immersed in distilled water in order to avoid contact with atmospheric oxygen. The potatoes were cubed rather than cut into French fries in order to be able to measure the color more easily with a Gardner Color Meter. The diced potatoes were dipped for one minute in the appropriate chemical solution and drained for five minutes before packing into polyethylene[3] or Cryovac[4] bags. The Cryovac bags were used without vacuuming or shrinking. Approximately 7 ounces were placed in each bag and three bags were packed for each treatment. Two bags were used for softness and color determinations at 9 and 16 days storage at 40-42° F. and the third was frozen after 16 days storage for determination of alcohol content.

The chemical solutions were made by diluting 70 per cent phytic acid[5] or 50 per cent calcium phytate[5] to the appropriate strength and adding sufficient U.S.P. sodium bisulphite to make the appropriate concentration of sulphur dioxide .

The alcohol determinations were made by the method of Shupe and Dubrowski (3). This method was designed for the detection of alcohol in blood and urine for forensic purposes and several other chemicals such as acetone and methyl alcohol will interfere with the determination in this application. There may have been other materials estimated as alcohol as samples of the distillate when analyzed with a Vapor Fractometer[6], showed the occasional presence of another chemical, but the major constituent was ethyl alcohol.

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[3]2x4x12 bags of 1 mil polyethylene obtained through the courtesy of the Shellmar-Betner division of the Continental Can Co., Newark, Ohio.

[4]5x16 bags obtained through the courtesy of the Cryovac Division of W. R. Grace & Co., Cambridge, Mass.

[5]Obtained through the courtesy of the A. E. Staley Co., Decatur, Ill.

[6]Manufactured by the Perkin-Elmer Corp., Norwalk, Conn.

The color determinations were made with a Gardner Color Difference Meter[7] equipped with small area illumination and an ebonite plate with a ½ inch circular hole. The instrument was standardized against a tile with color attributes — Rd = 61.5; a = —1.9; b = +23.1. The one inch cubes could be measured with a standard set-up and did not introduce an error due to loss of light from the edges of the cubes as was the case with French fries. In another project, an adapter with a small rectangular hole was designed for use with French fries, and it worked well for color differences. However, the absolute color values for the two methods were not in very close agreement. This was partially due to the thickness of the sample. The "Rd" readings were virtually constant with any thickness over 0.28 inches. The "b" readings increased until a thickness of 0.56 inches was used. The "a" readings changed very little with thickness of sample and were constant at 0.28 inch, and above. For French fries of ½ inch size, the "Rd" and "a" readings would not be affected by thickness, but the "b" readings would be slightly low, and there would be some loss of light through the edges of the cubes.

Ten to fifteen readings were taken on different cubes within the sample of potatoes because the range of color values within a single potato was considerable. The range in color readings, particularly in "Rd", was very large and varied from 44.3 to 51.5 for a vertical, longitudinal slice to 33.4 to 48.5 for a transverse slice. This effect may be due to variations in cell size or contents or even to the effect of polarized light the orientation of the starch granules in the potato cells. Whatever the reason, the experimental error is increased and a relatively large sample is required.

The softness determinations were made with a Universal Precision Penetrometer[8] with 150 grams weight on the bar.

The least significant differences were calculated by the method outlined by Tukey (5) for calculating the differences between means. The wholly significant difference was multiplied by the appropriate factor for number of treatments to obtain the least significant difference (L.S.D.) or gap as designated by Tukey.

Results and Discussion

It was apparent from earlier studies that neither phytic acid or calcium phytate solutions alone would prevent discoloration in pre-peeled potatoes. The levels used in this work were chosen to minimize tissue injury and to act in conjuction with sulphite solutions. The levels of sulphite chosen were lower than those usually used in commercial practice, because it was desirable to work at the minimum levels possible for chemical treatment.

Effects with Potatoes in Polyethylene Bags:

In table 1, data on visual discoloration and darkening as measured with a Gardner Color Difference Meter are presented. It is evident that phytic acid or calcium phytate solutions alone or in combination with 100 p.p.m. sulphur dioxide would not prevent discoloration after 9 days storage. One-half per cent phytate solutions plus 500 p.p.m. sulphur dioxide alone controlled discoloration for 9 days but not for 16 days,

[7]Manufactured by the Henry A. Gardner Co., Bethesda 14, Md.
[8]Manufactured by the A. S. Aloe Co., St. Louis 3, Mo.

TABLE 1.—*Discoloration of pre-peeled potatoes treated with solutions of phytic acid, calcium phytate and sodium bisulphite and packed in polyethylene bags.*

Treatment	Discoloration			
	Visual		"Rd" value	
	9 days	16 days	9 days	16 days
Phytic acid 0.7%	++*	++*	37.0	33.5
plus SO_2 100 p.p.m.	+	++	39.4	34.6
500 p.p.m.	0	+	44.1	41.3
1000 p.p.m.	0	0	46.4	40.6
L.S.D. for four treatments			2.9	2.5
Phytic acid 0.07%	++	++	37.6	37.5
plus SO_2 100 p.p.m.	+	++	42.6	40.7
500 p.p.m.	0	+	42.9	39.9
1000 p.p.m.	0	+	44.1	41.5
L.S.D. for four treatments			2.2	3.1
Calcium phytate 0.5%	++	++	38.8	36.4
plus SO_2 100 p.p.m.	+	++	39.3	40.4
500 p.p.m.	+	0	41.4	42.4
1000 p.p.m.	0	0	43.2	42.3
L.S.D. for four treatments			2.9	2.5
Calcium phytate 0.05%	++	++	37.7	34.2
plus SO_2 100 p.p.m.	+	++	39.8	38.0
500 p.p.m.	+	++	42.8	39.1
1000 p.p.m.	0	+	42.6	41.0
L.S.D. for four treatments			2.8	2.0
Sulphur dioxide 100 p.p.m.	+	+	39.3	37.0
500 p.p.m.	+	+	38.8	38.6
1000 p.p.m.	0	+	42.6	38.5
L.S.D. for three treatments			2.0	1.8
Control (no treatment)	++	++	32.6	decayed

*0 = none; + = slight; ++ = severe discoloration.

One-half per cent phytate solutions plus 1000 p.p.m. sulphur dioxide would prevent discoloration for sixteen days. A combination of 0.05 per cent phytate and 1000 p.p.m. sulphur dioxide would not maintain adequate color for 16 days.

In table 2, data on visual exudation, softness and alcohol content are presented for the same samples as in table 1. Exudation was not a serious problem at 9 days storage but became so with the more severe chemical treatments at 16 days.Apparently the two chemicals acted in conjuction to promote more exudation. The data for softness would be expected to parallel the degree of exudation because the cells become soft as they lose turgor. This trend is shown in table 2 particularly at the 16 day storage interval. The exudation and softening was also accomplished by a sharp rise in alcohol content which was confined to the samples treated with the more concentrated chemical solutions. It did not show up in the samples with sulphur dioxide alone or in the controls. The control samples showed excessive softening and exudation probably due to microbiological growth which was minimized in the chemically treated samples.

TABLE 2.—*Exudation and softening of pre-peeled potatoes treated with solutions of phytic acid, calcium phytate, and sodium bisulphite, and packed in polyethylene bags.*

Treatment	Softness			Softness			Alcohol mg./100 g.
	Visual Exudation	Visual 9 days	Penetrometer Storage	Visual Exudation	Visual 16 days	Penetrometer Storage	
Phytic acid 0.7%	0*	0*	32.2	0*	0*	33.4	<2
plus SO_2 100 p.p.m.	0	0	33.8	0	0	31.0	<2
500 p.p.m.	0	0	34.7	+	0	37.3	<2
1000 p.p.m.	0	0	32.0	+	+	36.1	106
L.S.D. for four treatments			2.6			4.4	
Phytic acid 0.07%	0	0	33.2	0	0	31.4	<2
plus SO_2 100 p.p.m.	0	0	33.3	0	0	33.7	<2
500 p.p.m.	0	0	31.8	0	0	35.3	<2
1000 p.p.m.	0	0	30.2	0	0	37.4	<2
L.S.D. for four treatments			3.5			3.4	<2
Calcium phytate 0.5%	0	0	34.8	0	0	33.4	<2
plus SO_2 100 p.p.m.	0	0	29.8	0	0	35.4	<2
500 p.p.m.	0	0	30.8	0	0	34.8	<2
1000 p.p.m.	0	0	39.0	+	+	49.0	108
L.S.D. for four treatments			3.8			7.6	
Calcium phytate 0.05%	0	0	33.4	0	0	33.6	<2
plus SO_2 100 p.p.m.	0	0	34.4	0	0	32.6	<2
500 p.p.m.	0	0	31.5	0	0	32.2	<2
1000 p.p.m.	0	0	36.3	0	0	34.9	<2
L.S.D. for four treatments			3.4			2.7	
Sulphur dioxide 100 p.p.m.	0	0	32.4	0	0	32.1	<2
500 p.p.m.	0	0	33.2	0	0	33.1	<2
1000 p.p.m.	0	0	33.7	0	0	36.0	<2
L.S.D. for three treatments			2.4			2.5	
Control (no treatment)	0	++	54.8	++	++	de-cayed	3

*0 = none; + = slight; ++ = severe exudation or softening.

The data in table 3 were taken from a different run and formed part of a bigger experiment. The trends were similar to those observed in tables 1 and 2. The "Rd" values for the higher concentrations of phytate and sulphur dioxide indicated that the tissues were slightly bleached or were actually whiter than when they were first packed. This bleaching effect was accompanied by evidence of tissue injury as shown by higher values for exudation, softening and alcohol production. There is obviously an optimum chemical treatment for quality retention as indicated by exudation and softening on one hand and discoloration on the other. The bleaching and softening are not characteristics caused by phytate solutions because high concentrations of sulphite alone will cause the same effects.

TABLE 3.—*Discoloration, exudation and softening of pre-peeled potatoes treated with solutions of phytic acid, calcium phytate and sodium bisulphite and packed in polyethylene bags, sixteen days storage.*

Treatment	Discoloration		Visual Exudation	Visual Softening	Alcohol mg./100 g.
	Visual	"Rd" value			
Phytic acid 2.1%	++*	38.7	0*	0*	<2
plus SO_2 500 p.p.m.	++	37.2	+	+	<2
1000 p.p.m.	0	45.6	++	++	100
Phytic acid 0.7%	++	37.2	0	0	<2
plus SO_2 500 p.p.m.	++	39.0	0	0	<2
1000 p.p.m.	0	45.0	++	++	85
L.S.D. for six treatments		2.8			
Calcium phytate 1.5%	++	38.8	0	0	<2
plus SO_2 500 p.p.m.	++	39.0	0	0	<2
1000 p.p.m.	0	46.8	++	++	87
Calcium phytate 0.5%	++	39.3	0	0	<2
plus SO_2 500 p.p.m.	++	37.2	0	0	<2
1000 p.p.m.	0	41.2	++	++	60
L.S.D. for six treatments		3.2			
Sulphur dioxide 500 p.p.m.	++	42.5	0	0	<2
1000 p.p.m.	++	42.2	0	0	<2
Control (no treatment)	++	35.9	0	0	<2

*0 = none; + = slight; ++ = severe discoloration, exudation or softening.

Effect with Potatoes in Cryovac Bags:

In table 4, data are presented on the effect of phytate solutions in combination with sulphite on the discoloration of prepeeled potatoes stored in Cryovac bags. The concentration of the chemical solutions was lowered for this set of samples because Anderson and Zapsalis (2) had shown that less severe treatment was needed when the samples were stored in Cryovac bags. Solutions of phytic acid and calcium phytate alone would not control discoloration. However, the inclusion of 200 or 400 p.p.m. sulphur dioxide did control the darkening effect. Solutions of 200 or 400 p.p.m. sulphur dioxide alone were inadequate except for the higher concentrations at 16 days. This anomaly was caused by an apparent reversion of color where the discoloration was evident at 10 days storage but not at 16. The same effect was observed with 0.5 per cent calcium phytate and sulphur dioxide.

In table 5, data are presented on the effect of phytate and sulphite solutions on exudation, softness and alcohol content of potatoes in Cryovac bags. Exudation or softening was not a severe problem in this experiment but in general, the phytate and sulphite treated potaotes were firmer than the samples with sulphite alone or the controls. The series with calcium phytate was firmer than the controls. The series with calcium phytate was firmer than the corresponding series with phytic acid. This effect is to be expected in view of the well known firming effect of calcium on plant tissue. The alcohol content for all samples in Cryovac was much higher than that for the samples in polyethylene bags. This is to be expected in view

TABLE 4.—*Discoloration of pre-peeled potatoes treated with solutions of phytic acid, calcium phytate and sodium bisulphite and packed in Cryovac bags.*

Treatment	Discoloration			
	Visual		"Rd" value	
	10 days	16 days	10 days	16 days
Phytic acid 1.4%	+*	+*	39.7	38.5
plus SO_2 200 p.p.m.	0	0	44.8	47.0
400 p.p.m.	0	0	43.6	44.9
Phytic acid 0.7%	+	+	38.4	36.9
plus SO_2 200 p.p.m.	0	0	44.9	45.9
400 p.p.m.	0	0	45.5	46.0
Phytic acid 0.35%	+	+	40.1	37.2
plus SO_2 200 p.p.m.	0	0	45.9	45.9
400 p.p.m.	0	0	45.4	48.4
L.S.D. for nine treatments			2.8	2.3
Calcium phytate 1.0%	+	+	41.4	39.6
plus SO_2 200 p.p.m.	0	0	43.3	45.6
400 p.p.m.	0	0	44.8	44.6
Calcium phytate 0.5%	+	+	36.3	37.0
plus SO_2 200 p.p.m.	0	0	43.7	46.5
400 p.p.m.	0	0	43.6	46.4
Calcium phytate 0.25%	+	+	39.3	36.0
plus SO_2 200 p.p.m.	0	0	45.8	45.3
400 p.p.m.	0	0	45.6	46.5
L.S.D. for nine treatments			2.4	2.4
Sulphur dioxide 200 p.p.m.	++	++	36.5	38.1
400 p.p.m.	+	0	38.7	45.4
Control (no treatment)	++	++	37.9	37.4

*0 = none; + = slight; ++ = severe discoloration.

of the lower oxygen permeability of the Cryovac film compared to polyethylene. Evidently more anaerobic respiration took place in the samples in Cryovac. The relationship between anaerobic respiration and quality retention is under investigation and will be reported in another paper.

The storage periods reported in this paper are much longer than would be found in normal commercial practice but they were chosen to emphasize the effects of the chemical treatment. Such storage times with minimum chemical treatment are possible in laboratory work due to the normally low microbiological contamination combined with adequate storage temperatures.

Organoleptic Evaluations:

This study was undertaken in order to determine whether phytic acid or calcium phytate in combination with sulphur dioxide or sulphur dioxide alone would have a detrimental effect on the cooked pre-peeled potato strips. However, the levels required to produce an off-flavor were considerably above those that could be used to keep the raw chips in good condition.

TABLE 5.—*Exudation and softening of pre-peeled potatoes treated with solutions of phytic acid, calcium phytate and sodium bisulphite and packed in Cryovac bags.*

Treatment	Visual Exudation	Softness		Alcohol mg./100 g.
		Visual	Penetrometer	
Phytic acid 1.4%	+*	0*	36.9	74
plus SO_2 200 p.p.m.	+	0	33.6	79
400 p.p.m.	+	0	32.6	88
Phytic acid 0.7%	+	0	34.9	67
plus SO_2 200 p.p.m.	+	0	36.5	90
400 p.p.m.	+	0	36.4	84
Phytic acid 0.35%	+	+	45.0	91
plus SO_2 200 p.p.m.	+	+	46.2	98
400 p.p.m.	++	++	55.7	89
L.S.D. for nine treatments			4.5	66
Calcium phytate 1.0%	0	0	35.1	95
plus SO_2 200 p.p.m.	0	0	33.4	93
400 p.p.m.	+	+	35.1	105
Calcium phytate 0.5%	0	0	33.4	87
plus SO_2 200 p.p.m.	0	0	34.8	81
400 p.p.m.	+	+	35.9	87
Calcium phytate 0.25%	0	0	33.1	66
plus SO_2 200 p.p.m.	0	0	32.6	126
400 p.p.m.	0	0	32.3	70
L.S.D. for nine treatments			3.0	43
Sulphur dioxide 200 p.p.m.	0	0	42.3	62
400 p.p.m.	+	+	41.6	65
Control (no treatment)	+	+	51.0	55

*0 = none; + = slight; ++ = severe exudation or softening.

The taste tests were conducted in the following manner. The potatoes were hand peeled, cut into French fry style, dipped in the appropriate chemical solution and stored for twenty-four hours at 40-42° F. prior to cooking. The chips were boiled in water until soft, drained and mashed before serving to a panel. The panel consisted of twenty people experienced in taste panel work with a variety of food products. Two standards made from fresh mashed potatoes with no chemical treatment were employed, one as open standard and the other was concealed in the line of treated samples. The panel members were asked to rate the samples from one to five according to the following description; one— definitely off-flavor; two— slightly off-flavor; three— below average flavor; four— average flavor; five— better than average flavor.

In one experiment, the four treatments consisted of mashed potatoes made from 1.4 per cent phytic acid plus 1000 p.p.m. sulphur dioxide, 1 per cent calcium phytate plus 1000 p.p.m. sulphur dioxide, 2000 p.p.m. sulphur dioxide alone and untreated fresh chips. Ten of the twenty members could not distinguish the fresh sample from the treated samples. With

the ten judges who could identify the concealed standard with the open standard, the scores for the samples with phytic acid plus sulphur dioxide and sulphur dioxide alone were lower than for the untreated samples. Scores for the samples with calcium phytate plus sulphur dioxide were significantly lower than for the fresh samples. However, these levels which were required to produce significantly different scores with judges who apparently could identify the standard, were higher than those which could be used due to biochemical injury to the raw potato slices .

Summary and Conclusions

Pre-peeled potatoes dipped for one minute in 0.7 per cent solution of phytic acid or 0.5 per cent calcium phytate and 1000 ppm sulphur dioxide and packed in polyethylene bags were not discolored after 16 days storage at 40-42° F.

Pre-peeled potatoes dipped for one minute in a 0.35 per cent solution of phytic acid or 0.25 per cent calcium phytate and 200 ppm sulphur dioxide and packed in Cryovac bags were not discolored after 16 days storage at 40-42° F.

The potatoes treated with calcium phytate were slightly firmer than those treated with phytic acid. More severe chemical treatment promoted excessive exudation and softening.

The alcohol content of the samples in Cryovac bags was considerably higher than the corresponding samples in polyethylene bags.

Potato chips treated with 1.4 per cent phytic acid plus 1000 ppm sulphur dioxide, 1.0 per cent calcium phytate plus 1000 ppm sulphur dioxide and 2000 ppm sulphur dioxide alone received lower scores from 10 judges who could identify the standard fresh sample when cooked and mashed. Ten other judges could not distinguish between the treated and untreated samples.

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HERBICIDAL AGENTS AS POSSIBLE AIDS FOR ROGUING DISEASED SEED-POTATO PLANTS[1]

GEORGE L. BARNES[2, 3]

INTRODUCTION

In order to meet certification standards, seed-potato growers have resorted to various cultural practices such as isolating plantings, eye-indexing, tuber-unit planting, vector control, and roguing of diseased plants. Despite these procedures, tubers grown for certification often have more disease than is acceptable.

Recent vector-control studies at Oregon State College have indicated that there may be less spread of virus diseases in unrogued than in rogued plots. This unexpected phenomenon suggested the possibility that aphids on the diseased plants were scattered to healthy plants during roguing, thus actually spreading viruses and defeating the main purpose of roguing.

An investigation was initiated in 1950 to determine if rapid-killing herbicides could be used as roguing agents to replace the tedious, costly, and inefficient hand-roguing methods in use. This work involved a search for economical herbicides which would quickly kill diseased potato vines and aphids simultaneously, and also prevent resprouting of the diseased seed pieces and tubers.

REVIEW OF THE LITERATURE

No work has been reported on the use of herbicides for spot roguing of diseased potato plants. Several herbicidal materials, however, have been used to kill stands of potato vines toward the end of the growing season to facilitate mechanical harvesting of the tubers, to prevent late season spread of viruses, to prevent spread of the late blight fungus from the foliage to the tubers, and to prevent the formation of oversized seed tubers (8, 9, 11). Most of these materials have little or no effect on the tubers, and their killing action is usually slow, often requiring a week or more to kill sprayed plants.

Several growth-regulating materials have been reported to have a killing or sprout-inhibiting effect on the tubers of sprayed potato plants. Foliar applications of solutions of the sodium salt, or methyl ester, of a-naphthalene-acetic acid have resulted in a low yield, a pitted "scab-like" injury to the tuber surface, and inhibition of sprouting during storage (3, 4, 12). Applications of dilute solutions of maleic hydrazide, or its diethanolamine salt, to the foliage of several potato varieties have resulted in a low yield and small tuber size, tuber injury, and an inhibition of

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[3]The author is indebted to Dr. J. A. Milbrath for his advise and criticism throughout the investigation.

sprouting from tubers in storage (1, 2, 7, 10, 13, 17). The tubers from such plants do not sprout even when held for five months at 45 or 55° F. (10, 17).

Foliar applications of aqueous solutions of 2, 4, 5-trichlorophenoxyacetic acid, or its butyl and isopropyl esters, have also resulted in a very low yield, injury to tubers and inhibition of sprouting even after long storage (4, 5, 6, 14). Application of the same materials in oil has increased the effect of some of these materials on yield and also their injurious effect on the epidermis of the tuber.

Aqueous solutions of growth regulators alone are not satisfactory because of their slow rate of kill and noninsecticidal properties. Certain salts and esters of growth regulators, however, are soluble in rapid-killing oils. Young (15, 16) has demonstrated that certain oils are translocated intercellularly to the tubers. Growth regulators dissolved or suspended in the oil may be similarly translocated and subsequently affect the tubers. This paper deals with mixtures of Diesel oil and certain growth-regulating compounds as experimental roguing agents.

Chemical-Roguing Trials

Materials and Methods

Several herbicidal materials (Table 1) were evaluated for their potato vine killing and tuber sprout inhibiting properties. Each material was sprayed onto potato plants with a hand sprayer for greenhouse tests and with a knapsack sprayer in field experiments. The plants were sprayed until the materials started to run off the leaves. Effects on the foliage, seed pieces, and new tubers were noted. Also, in those cases in which the treatment killed the foliage, the number of seed pieces from which new growth occurred was determined at the end of two to three months.

Results

Greenhouse grown Netted Gem potato plants, 3 to 10 inches in height, were used in the indoor tests. The materials which resulted in rapid killing were selected for further greenhouse and field testing.

The data from preliminary greenhouse and field trials showed that the most rapid kill resulted after application of three materials: Diesel oil, Shell Weedkiller 30, and Diesel oil containing one per cent Dow General Weed Killer. A Diesel oil application killed about 90 per cent of the aerial portions within 48 hours, but the two remaining materials killed the tops within four hours.

The three materials which gave the most rapid and efficient kill of sprayed foliage also resulted in the least amount of regrowth from the seed pieces or tubers. Regrowth data were recorded two months after spray applications, and the regrowth for each material was about 25 per cent (Table 2). When plants of various ages and sizes were sprayed with these materials, the percentages of regrowth were greater from seed pieces of small plants than from those of large plants. Factors independent of the foliar treatments may be responsible for this phenomenon. In the case of the older plants, the food reserves in the seed pieces may have been greatly depleted, making regrowth difficult and the seed piece subject to breakdown by microorganisms.

TABLE 1.—*Herbicidal compounds used in potato chemical-roguing trials in Oregon (1950-1953).*

Herbicidal Materials	Trade or Code Designations
Sodium pentachlorophenate 75 per cent, + other chlorinated phenols 15 per cent	Dowicide G
Ammonium sulfamate 80 per cent	Ammate
Ammonium thiocyanate	
Potassium cyanate + 0.1 per cent Vatsol K (a sodium dioctyl sulfosuccinate formulation)	Cyanate
2-Methyl-4-chlorophenoxyacetic acid	MCPA
Sodium acid cyanamid	
Malonic acid	
Tertiary butyl urea	
Phenyl mercuric acetate 40 per cent	PMAS
Sodium trichloroacetate 90 per cent	Sodium TCA
Methyl ester of trichloroacetic acid	TCA ester
Diethanolamine salt of maleic hydrazide	MH 30
The sodium bisulfite addition product of chloral hydrate	Chlorosol A
2, 3, 5-Triiodobenzoic acid	TIBA
Sodium 2, 4, 5-trichlorophenoxyacetate	Sodium 2, 4, 5-T
Mercapto-benzothiazole	
Chlorophenyl phthalamic acid	
N-phenyl phthalimide	Phthalanil
b, b'-dihydroxy ethyl sulfide	
Allyl mixed chlorophenylcarbonate	AMCC
Petroleum oil 82 per cent, 19.5 per cent pentachlorophenol, + 2.5 per cent other chlorophenols	Shell Weedkiller 30
Petroleum oil fraction 100 per cent	Shell Weedkiller 20
4, 6-dinitro ortho secondary butylphenol 55 per cent	Dow General Weed Killer
3, 6-endoxohexahydrophthallic acid	Endothal
Pentachlorophenol	PCP
Isopropyl ester of 2, 4-dichlorophenoxyacetic acid	2, 4-D ester
Coke by-products (liquid)	AS 80
Isopropyl N-phenylcarbamate	IPC
Isopropyl N-(3-chlorophenyl) carbamate	CIPC
Diesel oil	Diesel oil

Regrowth from virus infected seed-pieces is undesirable in seed potato fields as it provides a virus reservoir. Although the successful materials gave a complete and rapid vine kill, the use of materials that also prevent regrowth was deemed desirable.

The materials which gave the most rapid kill and the least regrowth in the preliminary greenhouse and field trials during 1950 and 1951 were tested under field conditions in 1952 with Netted Gem and White Rose potato plants. Application of the majority of these materials resulted in rapid kill and very little subsequent regrowth, below 20 per cent in most cases (Table 3). It has also been observed that many aphids were killed rather than dispersed to adjacent healthy plants. Tubers harvested from the plots were placed in cool storage. Six months later there was normal sprout growth from all of the tubers except those from plants sprayed with Diesel oil containing 1 per cent MH 30. This observation provided the basis for further greenhouse testing of Diesel oil and MH 30 combinations.

TABLE 2.—*Regrowth from seed pieces of two potato varieties top-killed with herbicides in field tests during 1951.*[1]

Initial Plant Height (Inches)	Regrowth Percentages					
	Diesel Oil		Diesel Oil + 1 per cent Dow General Weed Killer		Shell Weed-Killer 30	
	NG[2]	WR[3]	NG	WK	NG	WR
6-8	39	29	65	29	87	45
8-12	12	17	20	15	13	21
12-18	11	29	8	16	0	14
Averages	21	25	31	20	33	30

[1]Three replications (25 plants per replication) for each size group and variety.
[2]Netted Gem variety.
[3]White Rose variety

TABLE 3.—*Percentage regrowth from seed pieces of two potato varieties after top killing by foliar applications of herbicides in 1952.*[1]

Treatment	Regrowth Percentages			
	10-12" Vines		12-18" Vines	
	NG[2]	WR[3]	NG	WR
Diesel oil + 1 per cent Dow General Weed Killer	22.3	30.7	2.0	7.3
Diesel oil (20 per cent), Dow General Weed Killer (1 per cent), and water (79 per cent)	27.7	52.3	6.0	15.5
Diesel oil + 1 per cent MH 30	10.5	17.7	7.0	18.0
Diesel oil + 0.4 per cent 2, 4, 5-T (amine salt)	7.0	3.0	0.0	4.0
Diesel oil + 30 per cent CIPC emulsion	3.0	5.5	1.0	0.0
Diesel oil	2.3		2.7	
AS 80	7.7		0.7	

[1]Pooled data from three field experiments (three replications of 25 plants per replication for each treatment).
[2]Netted Gem variety.
[3]White Rose variety

Greenhouse trials in 1952 with mixtures of Diesel oil and various promising weed killers resulted in further data on the efficiency of Diesel oil and MH 30 combinations. When 5 or 10 per cent MH 30 was used, there was a pronounced inhibition of sprouting of the tubers harvested from the sprayed plants (Table 4). The data indicate that certain growth-regulating materials incorporated into Diesel oil and used as foliar sprays kill virus infected potato plants and inhibit the sprouting of most of their diseased tubers and seed pieces.

Use of Chemical Roguing by Seed Potato Growers

Several certified seed potato growers in Oregon have practiced chemical roguing on their seed crops for one or more years. These growers are enthusiastic about chemical roguing and plan to make it a standard roguing procedure. Chemical roguing has been accomplished with hand and power sprayers. The use of a tractor to carry the roguers to diseased plants greatly increases the efficiency of the operation. Chemical roguing eliminates hand pulling and the carrying of diseased plants from the fields, thereby reducing operator fatigue — a factor contributing to poor roguing. Unfortunately, seed pieces and any tubers under the killed vines must be dug, for the materials used by these growers have no detrimental effect on the tubers. Growers practicing chemical roguing have found that they can do a more efficient job with a smaller crew in a shorter period of time than can be done by hand roguing.

Summary

Several herbicidal materials were screened as possible roguing agents on potato plants. Most of the materials were rejected because of their slow killing action and failure to prevent regrowth from seed pieces. In greenhouse and field trials, Diesel oil plus 0.4 per cent triethanolamine salt of 2,4,5-trichlorophenoxyacetic acid, Diesel oil plus 30 per cent of an Isopropyl N-(3-chlorophenyl) carbamate emulsion, and Diesel oil plus 1 per cent Dow General Weed Killer were found to be suitable for roguing purposes. In subsequent greenhouse trials, a mixture of Diesel oil and 10 per cent MH 30 killed sprayed plants and inhibited sprouting of seed pieces and harvested tubers. This indicates that further work should be be done on mixtures of Diesel oil and the newer growth-regulating compounds as chemical roguing agents.

Trials by seed potato growers have indicated that transporting roguers, roguing chemicals, and spray equipment with a tractor to locate and spray diseased plants is a quick, efficient roguing method. At present, however, the seed-pieces and tubers under sprayed plants must be dug and destroyed before harvesting. Further research may bring forth an ideal herbicidal mixture which would kill all of the seed pieces and tubers of sprayed plants and thus eliminate the need for digging them. The consensus of interviewed growers was that chemical roguing costs less and is more efficient than hand roguing.

The results of these chemical-roguing investigations show that efficient, inexpensive, roguing materials can be used to replace the tedious, costly, and inefficient hand-roguing methods in current use.

TABLE 4.—*Regrowth from seed pieces and inhibition of sprouting of new tubers after foliage kill of Netted Gem plants. Preliminary greenhouse trials — 1952.*

Herbicide	Plant Height (Inches)	Regrowth[1]	Sprouting of Harvested Tubers (Per cent)
Diesel oil	6-8	30	100
Emulsion of Diesel oil + Dow General Weed Killer[2]	6-8	10	100
AS 80	4-6	20	100
	6-8	10	100
	8-10	0	100
	10-12	10	100
Diesel oil + 0.2 per cent 2, 4, 5-T (IPE)	4-6	50	100
Diesel oil + 0.4 per cent 2, 4, 5-T (IPE)	6-8	60	100
Diesel oil + 1 per cent MH 30	2-3	20	100
	3-4	30	100
	4-6	20	95
	6-8	15	100
	8-10	10	100
	10-12	20	100
Diesel oil + 5 per cent MH 30	2-3	20	93
	3-5	0	80
	4-6	10	55
	6-8	20	40
Diesel oil + 10 per cent MH 30	2-3	40	10
	4-6	20	30
	6-8	0	25
	8-10	20	10

[1]Percentage of seed pieces from which new growth occurred.
[2]Diesel oil (4 per cent), Dow General Weed Killer (1 per cent), ammonium sulfate (0.5 per cent), Tide (0.5 per cent) and water (94 per cent).

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PROGRAM OF THE 43rd ANNUAL MEETING OF THE POTATO ASSOCIATION OF AMERICA

August 12-16, 1959

UNIVERSITY OF NEW BRUNSWICK,

Fredericton, New Brunswick, Canada

Tuesday, August 11 and Wednesday, August 12, 1959

REGISTRATION

Aitken House

Wednesday, August 12, 1959

All-Day Tour to Potato Growing Areas in New Brunswick

Depart Student Centre, 8:00 A.M.

Thursday, August 13, 1959 to Monday, August 17, 1959

REGISTRATION

Lobby, Chemistry Building

Thursday Morning, August 13, 1959

Lecture Room, Chemistry Building, 9:00 a.m.

W. J. HOOKER, *President*, Presiding

Business Meeting and Committee Reports

Thursday Afternoon, August 13, 1959

Lecture Room, Chemistry Building, 1:30 p.m.

R. L. SAWYER, Presiding

1. **Potato production in India. (15 minutes).** E. J. WHEELER, Michigan State University, East Lansing, Michigan.
2. **Chipping quality and darkening during drying with slices of raw potatoes, as influenced by variety, place and storage time. (10 minutes).** H. O. WERNER, University of Nebraska, Lincoln, Nebraska.
3. **Production practices key to potato quality. (10 minutes).** PAUL N. MOSHER, University of Maine, Orono, Maine.

4. **Effect of variety, date of harvest and soil temperature on specific gravity of potatoes and color of potato chips. (15 minutes).** ORA SMITH, Cornell University, Ithaca, New York.

5. **Functions of the protein and other nitrogenous fractions of potatoes in chip color development. (10 minutes).** ORA SMITH and R. H. TREADWAY, Cornell University, Ithaca, New York and Eastern Utilization and Development Division, U. S. Department of Agriculture, Philadelphia, Pennsylvania.

6. **Treatment of whole and sliced potatoes to improve chip color. (12 minutes).** ORA SMITH, Cornell University, Ithaca, New York.

7. **Placement and source of potash on yield and solids content of potatoes. (15 minutes).** ARTHUR HAWKINS, University of Connecticut, Storrs, Connecticut.

8. **Effect of time and method of vine killing and date of harvest on yield, specific gravity, tuber skinning, and chip color index of the Katahdin and Russet Burbank potato varieties. (15 minutes).** H. J. MURPHY and MICHAEL GOVEN, University of Maine, Orono, Maine.

9. **Use of alcohol for sprout inhibition. (10 minutes).** R. L. SAWYER, Cornell University, Riverhead, New York.

10. **Potato planter attachment for dispensing weighed quantities of fertilizer for potato plots. (15 minutes).** ARTHUR HAWKINS, University of Connecticut, Storrs, Connecticut.

11. **Efficiency in the use of water by potatoes. (15 minutes).** R. A. STRUCHTEMEYER, University of Maine, Orono, Maine.

12. **Irrigation and soil management studies with potatoes in New Jersey. (12 minutes).** G. D. BRILL, J. C. CAMPBELL and G. R. BLAKE, U. S. Department of Agriculture and New Jersey Agricultural Experiment Station, New Brunswick, New Jersey.

Thursday Evening, August 13, 1959

Canada Department of Agriculture Research Station, Fredericton,

5:30 to 7:30 p.m.

Chicken Barbecue for delegates and their families

Tour of Research Station, 7:00 p.m.

Friday Morning, August 14, 1959

Lecture Room, Chemistry Building, 9:00 a.m.

D. S. MAC LACHLAN, Presiding

1. **Seed certification in Maine. (10 minutes).** P. J. EASTMAN, Department of Agriculture, Augusta, Maine.

2. **Mineral nutrition of potatoes. (15 minutes).** PAUL N. CARPENTER, University of Maine, Orono, Maine.

3. **Some effects of chloride in the nutrition of the potato plant. (15 minutes).** HAROLD W. GAUSMAN, University of Maine, Orono, Maine.

4. **Some effects of various sulfur to magnesium ratios on potatoes. (15 minutes).** GEORGE O. ESTES and HAROLD W. GAUSMAN, University of Maine, Orono, Maine.

5. **Factors affecting and methods of testing potato varieties for heat and drouth resistance. (15 minutes).** R. B. O'KEEFE, University of Nebraska, Lincoln, Nebraska.

6. **Inheritance of immunity to virus S in potato. (15 minutes).** R. H. BAGNALL and D. A. YOUNG, Canada Department of Agriculture, Fredericton, New Brunswick, Canada.

7. **Potato virus S recovered from the roots of the "immune" variety Saco. (15 minutes).** R. H. LARSON and N. OSHIMA, University of Wisconsin, Madison, Wisconsin.

8. **Purification and physical chemical studies of potato virus X. (10 minutes).** W. S. KIM and W. J. HOOKER, Michigan State University, East Lansing, Michigan.

9. **Studies on degradation products of purified potato virus X. (10 minutes).** W. S. KIM and W. J. HOOKER, Michigan State University, East Lansing, Michigan.

10. **Inhibitors of potato virus X in leaves of potatoes with different types of resistance to the virus. (10 minutes).** W. J. HOOKER and W. S. KIM, Michigan State University, East Lansing, Michigan.

11. **Distribution of potato virus X in tolerant potatoes. (10 minutes).** W. J. HOOKER, W. S. KIM and N. R. THOMPSON, Michigan State University, East Lansing, Michigan.

12. **Resistance to infection by mechanical inoculation with virus X in potato. (10 minutes).** A. E. KEHR and J. C. HORTON, U. S. Department of Agriculture, Beltsville, Maryland and Iowa State University, Ames, Iowa.

Friday Afternoon, August 14, 1959

Lecture Room, Chemistry Building, 1:30 p.m.

D. A. YOUNG, Presiding

1. **Erendira, a new blight-resistant potato variety for the high lands of Central Mexico. (8 minutes).** J. S. NIEDERHAUSER, R. W. BUCK and R. V. AKELEY, Rockefeller Foundation, Mexico, D. F., and U. S. Department of Agriculture, Beltsville, Maryland.

2. **Anita, Bertita, and Conchita, three new blight-resistant potato varieties developed in Central Mexico. (10 minutes).** JOHN S. NIEDERHAUSER and JAVIER CERVANTES, Rockefeller Foundation, Mexico, D. F., and Office of Special Studies, Department of Agriculture, Mexico, D.F.

3. **A technique for evaluating the ability of selections to yield consistently in different locations or seasons. (12 minutes).** ROBERT L. PLAISTED, Cornell University, Ithaca, New York.

4. **A comparison of pollen behavior and pollen-tube growth in styles of potato flowers grown on cuttings with that of flowers remaining on the plant. (15 minutes).** DARREL R. BIENZ, U. S. Department of Agriculture, Aberdeen, Idaho.

5. **Analytical methods for potato tuber composition. (15 minutes).** EDWARD F. HOOVER and PAUL A. XANDER, Wise Potato Chip Company, Berwick, Pennsylvania.

6. **Appearance and detection of diploid plants (2 = 24) in seedling populations of *Solanum tuberosum*. (15 minutes).** G. H. RIEMAN, D. C. COOPER and P. M. TSENG, University of Wisconsin, Madison, Wisconsin.

7. **Induced seed formation without pollination in *Solanum tuberosum L.* (10 minutes).** N. R. THOMPSON, Michigan State University, East Lansing, Michigan.

8. **Haploidy in *Solanum tuberosum* and in the sub-species *Andigena*. (12 minutes).** S. J. PELOQUIN and R. W. HOUGAS, U. S. Department of Agriculture, Madison, Wisconsin.

9. **Hybrids of *Solanum tuberosum* haploids and the tuber-bearing Solanum species. (12 minutes).** R. W. HOUGAS and S. J. PELOQUIN, U. S. Department of Agriculture, Madison, Wisconsin.

Friday Evening, August 14, 1959

Lord Beaverbrook Hotel, 6:30 p.m.

RECOGNITION BANQUET

Presentation of 1959 Honorary Life Memberships

W. J. HOOKER, *President*, Presiding

Saturday Morning, August 15, 1959

Lecture Room, Chemistry Building, 9:00 a.m.

Business Meeting

W. J. HOOKER, *President*, Presiding

Saturday Afternoon, August 15, 1959

Lecture Room, Chemistry Building, 1:30 p.m.

Invitational Papers

R. H. LARSON, Presiding

1. **A necrotic type of potato virus. (20 minutes).** Y. M. KLINKOWSKI, Biologische Zentralanstalt, Aschersleben, Germany.
2. **History and recent observations on types of potato virus Y necrotic to tobacco. (20 minutes).** KARL M. SILBERSCHMIDT, Instituto Biologico, Sao Paulo, Brazil.
3. **Tobacco mosaic virus carried in potato tubers. (20 minutes).** HENNING P. HANSEN, The Royal Veterinary & Agricultural College, Virological Laboratory, Rolighedsvej 23, Copenhagen V, Denmark.
4. **Simple designations of potato-infecting viruses in accordance with the periodical system of plant and animal virus interrelationships. (20 minutes).** HENNING P. HANSEN, The Royal Veterinary & Agricultural College, Virological Laboratory, Rolighedsvej 23, Copenhagen V, Denmark.
5. **Relation between absorption of potassium and phosphates by potatoes and the development of virus diseases in their tissues. (20 minutes).** ANIELA KOZLOWSKA, Plant Pathology, School of Agriculture, Al. Mickiewicza 21, Cracow, Poland.
6. **Detection of latent strains of potato virus X by ultraviolet light. (20 minutes).** ANIELA KOZLOWSKA, Plant Pathology, School of Agriculture, Al. Mickiewicza 21, Cracow, Poland.
7. **Some recent developments in indexing virus infected potato plants in the Netherlands. (20 minutes).** D. H. M. VAN SLOGTEREN, Flower Bulb Research Laboratory, Lisse, The Netherlands.
8. **Studies on the etiology of spraing. (20 minutes).** D. LIHNELL, Swedish State Plant Protection Institute, n. Stockholm, Sweden.

Sunday, August 16, 1959

All-day tour to Potato Breeding Isolation Station, Alma

Depart, Student Centre, 8:00 a.m.

Monday, August 17, 1959

Post-Conference tour and visit to Aroostook Farm, Presque Isle, Maine.

Depart, Student Centre, 8:00 a.m.

1959 COMMITTEE MEMBERSHIP
POTATO ASSOCIATION OF AMERICA

OFFICERS AND EXECUTIVE COMMITTEE

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P. J. Eastman ..... *President-elect*
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STANDING COMMITTEES

Program

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Auditing

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Committee on Local Arrangements

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Editorial Board

J. C. Campbell,* Arthur Hawkins, A. F. Ross, G. W. Simpson, Ora Smith, R. E. Webb.

SPECIAL COMMITTEES

Handbook

J. C. Campbell,* Potato Utilization Committee, and Executive Committee of the Association.

Honorary Life Membership

N. M. Parks,* Executive Committee plus the 10 immediate past presidents.

Policy

G. H. Rieman,* F. J. Stevenson, C. B. Frutchey, P. J. Eastman.

Potato Certification

H. M. Darling,* Karl Fernow, R. C. Hastings, T. H. Hankins, D. L. Clanahan, C. W. Frutchey.

Late Blight Investigations

C. J. Eide,* John Niederhauser, W. R. Mills, R. Bonde, M. E. Gallegley, K. Graham, J. R. Wallin.

Virus Disease Investigations

R. E. Webb,* R. H. Larson, D. S. MacLachlan, N. S. Wright, W. G. Hoyman, C. H. Livingston.

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Potato Nutrition

R. V. Houghland,* A. Hawkins, L. M. Ware, R. L. Sawyer, D. A. Lorenz, N. R. Richards.

Varietal Description and Nomenclature

N. R. Thompson,* R. V. Akeley, H. M. Darling, J. C. Miller.

Genetics and Cytology of Tuber Bearing Solanums

L. A. Dionne,* R. W. Buck, Paul Grun, K. Graham, R. W. Hougas, F. L. Haynes, A. E. Kehr, F. Louer, R. Plaisted, S. J. Peloquin, D. A. Young.

Publicity

A. E. Mercker,* and Executive Committee of the Association.

International Relations

United States. R. H. Larson,* R. V. Akeley, D. S. Correll, C. W. Frutchey, Ora Smith.

Canada. D. S. MacLachlan, L. C. Young, N. S. Wright.

Central and South America. E. H. Casseres, J. Cervantes, N. Estrada, A. B. Montaldo, Carlos Ochoa, K. M. Silberschmidt, M. F. Fernandez Valiela.

Europe. Maria-Luise Baerecke, George Cuckerham, J. G. Hawkes, C. Martin, J. Munster, A. Rozendaal, D. H. M. van Slogteren, Carl Wetter.

Invitational Papers for 1959 Meetings.

R. H. Larson,* D. S. MacLachlan, Ora Smith, L. C. Young.

Coordinator of Committees

P. J. Eastman.

*Chairman.

THE 43rd ANNUAL MEETING

THE POTATO ASSOCIATION OF AMERICA

UNIVERSITY OF NEW BRUNSWICK

FREDERICTON, N. B., CANADA

AUGUST 12 - 16, 1959

General Information

TRANSPORTATION. The city of Fredericton is serviced by Trans Canada Airlines, Canadian Pacific and Canadian National Railways and is located on the Trans Canada Highway. If you plan to travel by plane, when you make your plane reservation tell your ticket agent that you are attending these meetings. On arrival in Fredericton if you cannot locate the University contact the Tourist Information Bureau or phone 5-3519.

TWO TOURS will be conducted during the meetings. On August 12 there will be a tour up the Saint John River Valley into the potato production area with stops at several points of interest. On August 16 a tour will be made to the Canada Department of Agriculture Potato Breeding Sub-Station at Alma, in the centre of Fundy National Park. For those wishing to stay there longer excellent facilities for camping, golfing, lawn bowling, tennis, and salt water swimming are available. Arrangements have been made with the Maine Agricultural Experiment Station and the U.S.D.A. to welcome visitors on Monday, August 17 at Aroostook Farm, Presque Isle, Maine. Transportation for this *Post Conference Tour* from Fredericton to Presque Isle and return will be available for those requesting it. *Please indicate on the reservation form if you plan to participate in any of these tours,* so that adequate transport will be available. The August 12 and August 16 tours leave Fredericton at 8 a.m., the chartered buses departing from the Student Centre at the University. The transportation facilities and meals en route will probably be free of charge but it may be necessary to charge a moderate fee for transportation. *Those taking the August 12 tour should arrive in Fredericton August 11.*

RESIDENCE ACCOMMODATIONS at the University will be available for single persons, couples, and families. Rates at the University per person for Meals and Room are: August 11-17, $27.15; August 12-17, $23.80; August 12-16, $20.45; August 11-16, $23.80. Charges for periods stated include evening meal on day of arrival and breakfast on day of departure and all other meals except when on tour. Rates for children 12 years and under one-half price. Towels are supplied.

REGISTRATION AND HOUSING APPLICATION

Name MR. / MRS. / MISS ..... (Surname) (First) (Middle)

Title .....

Institution .....

Address .....

Expected time of arrival at Fredericton

..... Date and Hour

☐ By plane
☐ By train
☐ By car

I shall be accompanied by

Wife: ☐ who will ☐, will not ☐ participate in the ladies program.

Wife's name .....

Children: ☐ who will ☐, will not ☐, participate in program of recreation (list children's name, age and sex).

Name Age Sex

.....

.....

.....

.....

Expected time of departure from Fredericton:

..... Date and Hour

Please make reservations for the above in a University Residence ☐
I would prefer housing in a hotel ☐, motel ☐, tourist camp ☐, camp site ☐.

I will not require housing ☐.
I wish to share a room with .....

Remarks: .....

I plan to take the following field trips:
☐ August 12 — Saint John River Tour. I will be accompanied by ..... members of my family.
☐ August 16 — Alma Potato Sub-Station Tour. I will be accompanied by ..... members of my family.
☐ August 17 — Aroostook Farm, Presque Isle Tour. I will ☐, will not ☐ require transportation.

Please print or type the above information and mail to:

Mrs. M. E. MacGillivray,
C.D.A. Research Station,
P. O. Box 280,
Fredericton, N. B., Canada.

Date ..... Date Received .....

RESERVATIONS CANNOT BE GUARANTEED AFTER JULY 25.

WHAT POTATO GROWERS SAY

about controlling blight with

DITHANE® M-22*

"... 30 barrels more per acre."

We tried DITHANE M-22 on about 10 acres of potatoes during 1958 with very satisfying results. During August, about 9 inches of rain fell, and late blight became a serious threat to Aroostook County potato crop. We feel that DITHANE M-22 passed a severe test by giving us better blight control than we had with the nabam fungicide used on the balance of the crop. In addition to the excellent disease control, we had an increase in yield amounting to 30 barrels per acre.

Alfred J. Lausier, KVL FARMS, PRESQUE ISLE, MAINE

"... prefer working with DITHANE M-22."

DITHANE M-22 helped us grow a good clean crop of potatoes last season. Weather conditions during 1958 were very favorable for blight and it was present in the county, but DITHANE M-22 kept our vines clean until harvest. We would also prefer working with DITHANE M-22 to other materials. It is convenient to handle and mixes readily.

J. A. Jones & Son, R.D. #1, BATH, PA.

The reports are the same from all over the country—outstanding potato blight control... better yields ... ease of handling and mixing ... and definite plans to use DITHANE M-22 on a larger scale this season. If you haven't yet discovered the proved advantages of this improved maneb fungicide, check with your Rohm & Haas fieldman or your pesticide dealer before another day goes by. You'll like the results.

"... exceptional control of late blight."

I used DITHANE M-22 on my entire crop of certified seed potatoes during the 1958 season and I feel that the performance of the product was outstanding. During the month of August, we had an excessive amount of rain in Aroostook County and late blight rapidly developed in the area. Despite these severe disease conditions, DITHANE M-22 prevented any late blight development in my crop. Under the circumstances, I feel that DITHANE M-22 gave me exceptional control of late blight.

Athell Banks, MARS HILL, MAINE

"... plan to continue using DITHANE M-22."

Since I grow, buy, and sell potatoes and also sell pesticides, I am in a good position to judge fungicides. My opinion is that DITHANE M-22 does an outstanding job of controlling blight on potatoes. I plan to continue using DITHANE M-22 and will recommend it to all my potato-growing customers.

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